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0037040

JUN 10 1994 (11)

Station #12

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 606171

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Environmental Engineering	4. Related EDT No.:
5. Proj./Prog./Dept./Div.: 100 Area Soil Washing	6. Cog. Engr.: J. G. Field	7. Purchase Order No.: N/A
8. Originator Remarks: To be released and distributed.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date:

JUN 1994 RECEIVED EDMC

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-EN-TI-255		Rev 0	Soil Washing Field Test Procedure for the 100-DR-1 Operable Unit	QS	1/2	1	

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 4. Review 2. Release 5. Post-Review 3. Information 6. Dist. (Receipt Acknow. Required)	1. Approved 4. Reviewed no/comment 2. Approved w/comment 5. Reviewed w/comment 3. Disapproved w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)

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1	1	Cog.Eng. J. G. Field	J. G. Field	6/7/94	H6-05	J. M. Ayres			H6-02	3	
1	1	Cog. Mgr. J. G. Woolard	J. G. Woolard	6/8/94	H6-05	J. K. Patterson			H6-27	3	
1	1	QA ~~D. D. Volkman~~ G. S. Gorring	[signature]		H4-25	R. Thomas			H6-27	3	
1	1	Safety M. A. Tredway	[signature]	6/10/94	R3-56	EPIC (2)			H6-08	3	
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1	1	R. P. Henckel	R P Henckel	6-9-94	H6-02	Central Files (2)			L8-04	3	
3		R. D. Belden			H6-05						

18.	19.	20.	21. DOE APPROVAL (if required)
J. G. Field 6/7/94 J. G. Field Signature of EDT Originator / Date	Authorized Representative for Receiving Organization / Date	J. G. Woolard 6/8/94 J. G. Woolard Cognizant/Project Engineer's Manager / Date	Ltr. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (07/91) GEF097

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List attachments.

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Title: Soil Washing Field Test Procedure for the 100-DR-1 Operable Unit

Unclassified Category: UC-

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	Yes	No
References Available to Intended Audience	[X]	[]
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Author/Requestor (Printed/Signature): J. G. Field — J. G. Field — Date: 6/2/94

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Responsible Manager (Printed/Signature): J. G. Woolard — J. G. Woolard — Date: 6/2/94

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SUPPORTING DOCUMENT

1. Total Pages 56

2. Title

Soil Washing Field Test Procedure for the 100-DR-1 Operable Unit

3. Number

WHC-SD-EN-TI-255

4. Rev No.

0

5. Key Words

Treatability
CERCLA
Pilot Test
Attrtion Scrubbing

APPROVED FOR PUBLIC RELEASE
6/7/94 N. Dolic

6. Author

Name: J. G. Field

J. G. Field
Signature

Organization/Charge Code 85910/P71AA

7. Abstract

J. G. Field, 1994, Soil Washing Field Test Procedure for the 100-DR-1 Operable Unit, perpared by Enserch Environmental Corporation.

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9. Impact Level QS

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WHC-SD-EN-TI-255
Revision 0

Soil Washing Field Test Procedure for the 100-DR-1 Operable Unit

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

Approved for Public Release

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TABLE OF CONTENTS

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LIST OF ACRONYMS

ALARA	as low as reasonably achievable
CLP	contract laboratory program
CRDL	contract required detection limit
CRQL	contract required quantitation limit
DOE	U.S. Department of Energy
dps	disintegrations-per-second
EPA	U.S. Environmental Protection Agency
FTL	Field Team Leader
ICP/MS	inductively coupled plasma/mass spectrometer
IG	intrinsic-germanium
MDA	minimum detectable activity
MDC	minimum detectable concentration
PNL	Pacific Northwest Laboratory
PWC	purgewater criteria
QA	quality assurance
QC	quality control
QAPjP	quality assurance project plan
RCRA	Resource Conservation and Recovery Act
RL	DOE, Richland Operations Office
rpm	revolutions per minute
TCLP	toxicity characteristic leaching procedure
TPG	test performance goals
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	transuranic
WHC	Westinghouse Hanford Company
XRF	X-ray fluorescence

Metric Conversion Chart

The following conversion chart is provided to the reader as a tool to aid in conversion.

Into Metric Units

If You Know	Multiply By	To Get
Length		
inches	25.4	millimeters
inches	2.54	centimeters
feet	0.305	meters
yards	0.914	meters
miles	1.609	kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	metric ton
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters

Out of Metric Units

If You Know	Multiply By	To Get
Length		
millimeters	0.039	inches
centimeters	0.394	inches
meters	3.281	feet
meters	1.094	yards
kilometers	0.621	miles
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.76	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.4	sq. miles
hectares	2.47	acres
Mass (weight)		
grams	0.035	ounces
kilograms	2.205	pounds
metric ton	1.102	ton
Volume		
milliliters	0.033	fluid ounces
liters	2.1	pints
liters	1.057	quarts
liters	0.264	gallons
cubic meters	35.315	cubic feet
cubic meters	1.308	cubic yards

Into Metric Units

If You Know	Multiply By	To Get
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius

Out of Metric Units

If You Know	Multiply By	To Get
Temperature		
Celsius	multiply by 9/5, then add 32	Fahrenheit

1.0 INTRODUCTION

This document will be the controlling document for the Pilot Plant Testing of two soil washing processes designed to reduce the volume of contaminated soil in the 100 Area trenches. The testing is designed to fulfill requirements of Milestone M-15-07B of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989). The discussion and procedures in this document are in accordance with the *100 Area Soil Washing Treatability Test Plan* (DOE-RL 1992a). The procedures contain all of the elements required for a Description of Work. Also, it is important to note that the field tests described in this document will not impact groundwater at the Hanford Site.

The soil washing equipment to be used in the Pilot Plant Tests is shown on the process flow diagram (Figure 1-1) and the general arrangement drawing (Figure 1-2). Tables 1-1 and 1-2 list typical stream mass balance flow rates for the wet sieve-water process and the attrition scrubber-solution process. These mass balance values, equipment types, and process arrangements have been selected to meet the Requirements and Scope described in Section 1.1 and the Objectives and Measurements described in Section 1.2.

1.1 REQUIREMENTS AND SCOPE

The requirements and scope for the Pilot Plant Tests of soil washing equipment are described in Sections 1.1.1 through 1.1.9.

1.1.1 Field Pre-Test

The field pre-test will include setting up the equipment, obtaining operating experience, and selecting operating parameters for Field Tests 1 and 2. The field pre-test is described in detail in Section 2.2.

1.1.2 Field Test 1

The purpose of Field Test 1 is to process contaminated soils to determine the effectiveness of wet sieving and attrition scrubbing with water as a means of reducing the volume of contaminated soils. The test will be divided into two parts: (1) wet sieving with water, followed by (2) attrition scrubbing with water. The equipment used will include a trommel, screens, attrition scrubber, dewatering screen, clarifiers, pumps, and conveyors. Field Test 1 is described in detail in Section 2.3.

1.1.3 Field Test 2

Field Test 2 will be the same as Field Test 1 except an electrolyte solution of 0.5 *M* ammonium citrate and enough citric acid to reach a final pH of 3 will be added to the attrition scrubbers to inhibit reabsorption and enhance removal of ^{137}Cs. Field Test 2 is described in detail in Section 2.4.

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Figure 1-1. 100 Area Soil Washing Treatability Test Process Flow Diagram.

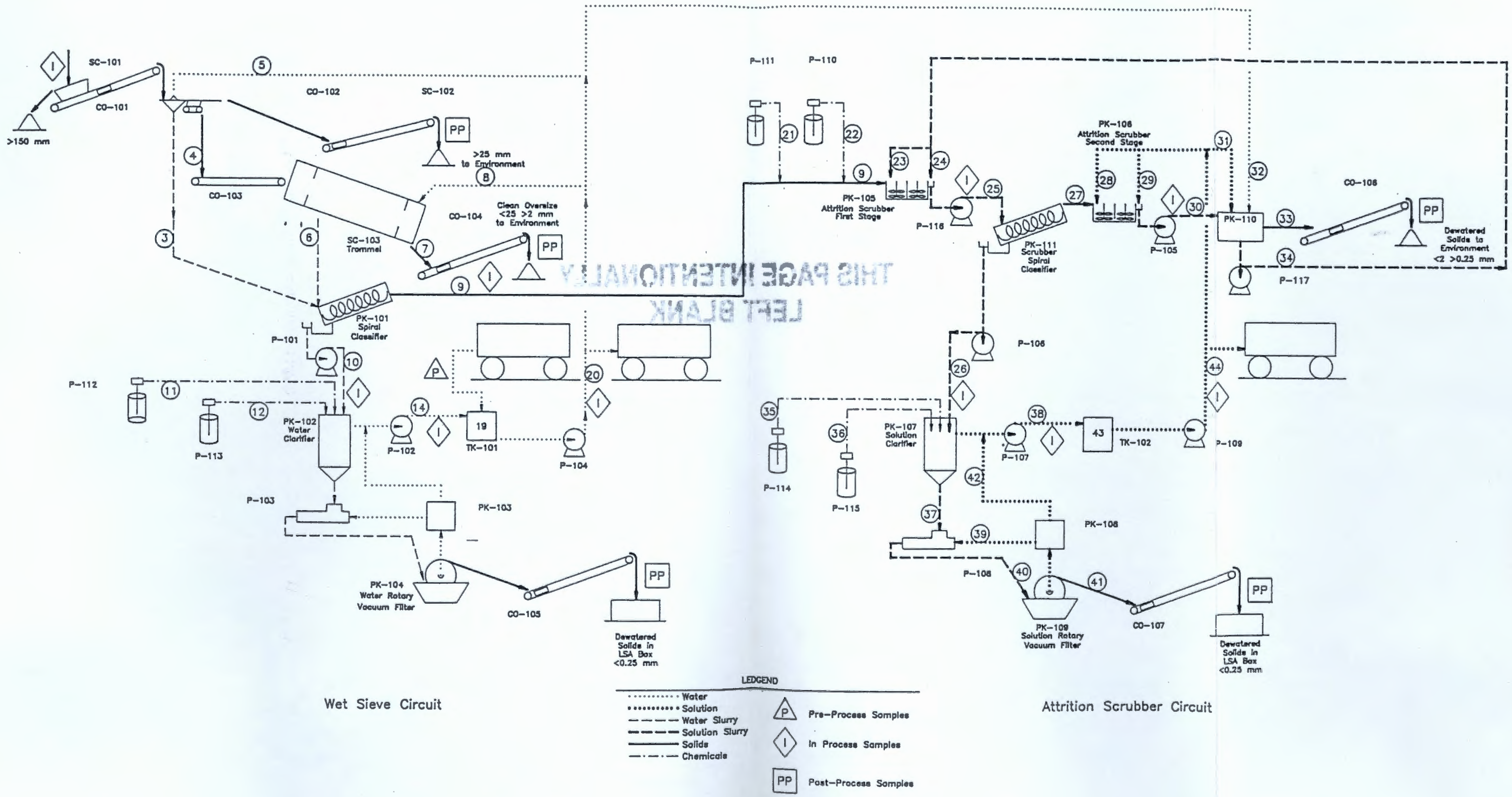

Figure 1-1. 100 Area Soil Washing Treatability Test Process Flow Diagram.

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Figure 1-2. 100 Area Soil Washing Treatability Test General Arrangement.

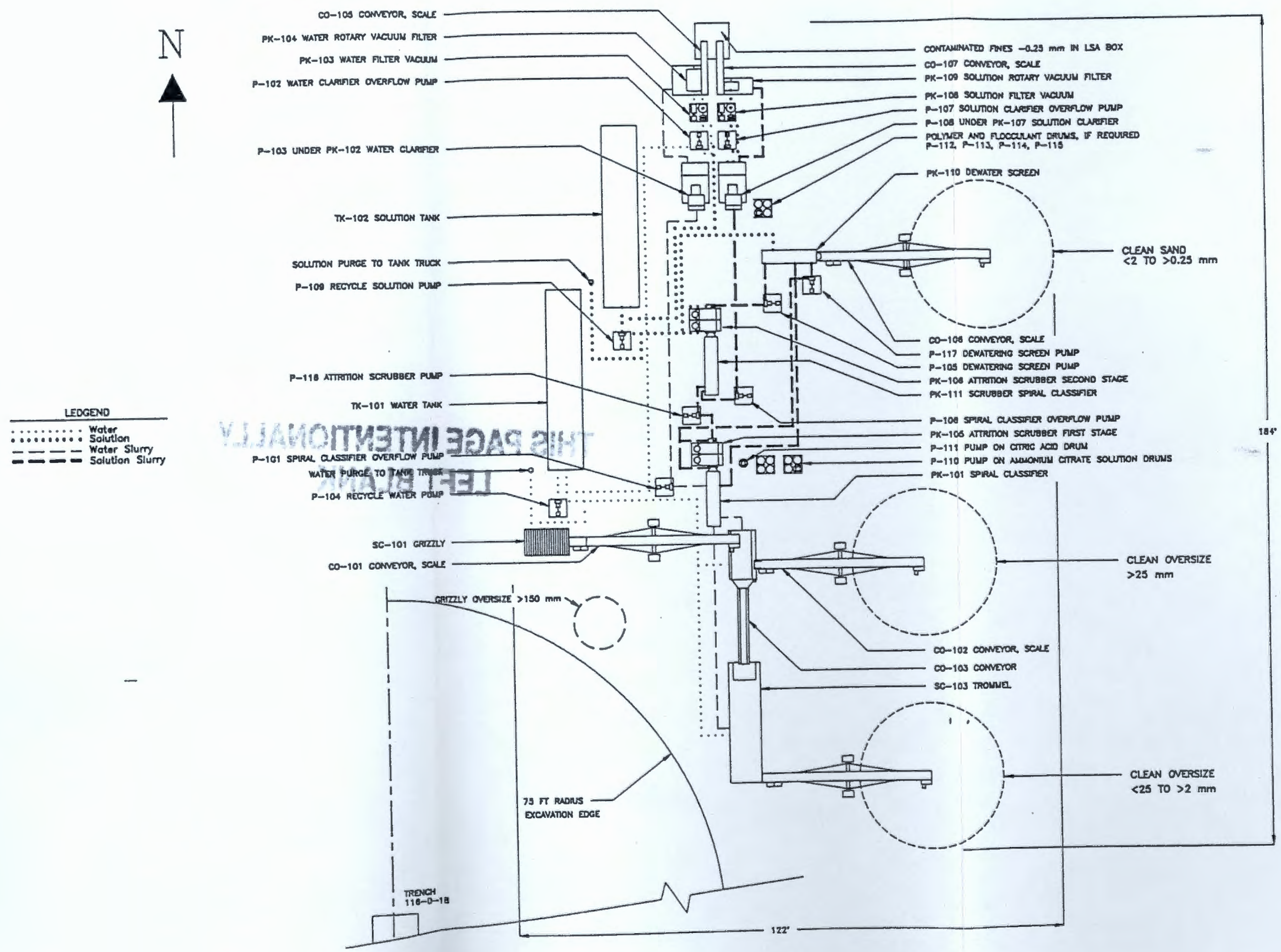

Figure 1-2. 100 Area Soil Washing Treatability Test General Arrangement.

SK102-R3.DWG, 5/26/94

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Table 1-1. Wet Sieving Circuit Mass Balance.

Stream Number	Soil Feed from Grizzly 1	Primary Screen Oversize 2	Fines To Spiral Classifier 3	Solids to Trommel 4	Water to Primary Screen 5 (b)	Fines From Trommel 6	Clean Oversize to Environment 7	Recycle Water to Trommel 8 (b)
33.7% +25mm, lb/hr	6,740	6,740						
7.9% -25 +9.5mm, lb/hr	1,580			1,580			1,580	
5.3% -9.5 +2mm, lb/hr	1,060			1,060			1,060	
40.7% -2 +0.25mm, lb/hr	8,140			8,140		8,140		
4.8% -0.25 +0.074mm, lb/hr	960			960		960		
7.4% -0.74 +0.028mm, lb/hr	1,480			1,480		1,480		
2% -0.028mm, lb/hr	40		40					
Total Solids, lb/hr	20,000	6,740	40	13,220		10,580	2,640	
Water, lb/hr	3,300	355	3,950	3,995	5,000	45,202	293	41,500
Total, lb/hr	23,300	7,095	3,990	17,215	5,000	55,782	2,933	41,500
Solids Weight %	86	95	1	77	0.003	19	90	0.003
Total Flow, gal/min			7.9		10	98		83
Total Volume, ft3/min	2.80	0.77		2.39		13.05	0.34	
Average Specific Gravity	2.23	2.46	1.01	1.92		1.14	2.28	
Solids Specific Gravity (c)	2.79	2.66	2.9	2.66		2.9	2.66	
(Solids/Stream 1 Solids) %	100	34	0	66	0	53	13	0

Stream Number	Spiral Classifier Sands 9	Fines to Water Clarifier 10	Water Clarifier Flocculant 11 (a)	Water Clarifier Polymer 12 (a)	Water Clarifier Underflow 13	Water to Tank TK-101 14 (b)	Motive Water 15 (b)	Water to Filter 16
33.7% +25mm, lb/hr								
7.9% -25 +9.5mm, lb/hr								
5.3% -9.5 +2mm, lb/hr								
40.7% -2 +0.25mm, lb/hr	8,140							
4.8% -0.25 +0.074mm, lb/hr		960			960			960
7.4% -0.74 +0.028mm, lb/hr		1,480			1,480			1,480
2% -0.028mm, lb/hr		40			40			40
Total Solids, lb/hr	8,140	2,480			2,480			2,480
Water, lb/hr	2,035	47,117			14,053	46,497	14,053	28,107
Total, lb/hr	10,175	49,597			16,533	46,497	14,053	30,587
Solids Weight %	80	5			15	0.003	0.003	8
Total Flow, gal/min		96	4 gal/hr	2.5 gal/hr	30	93	28	58
Total Volume, ft3/min	1.29							
Average Specific Gravity	2.10	1.03			1.11			1.06
Solids Specific Gravity (c)	2.9	2.9			2.9			2.9
(Solids/Stream 1 Solids) %	41	12	0	0	12	0	0	12

Stream Number	Water Filter Solids 17	Water Filter Filtrate 18 (b)	TK-101 Water Loss 19 (b)	Recycle Water 20 (b)	Clean Water 45			
33.7% +25mm, lb/hr								
7.9% -25 +9.5mm, lb/hr								
5.3% -9.5 +2mm, lb/hr								
40.7% -2 +0.25mm, lb/hr								
4.8% -0.25 +0.074mm, lb/hr	960							
7.4% -0.74 +0.028mm, lb/hr	1,480							
2% -0.028mm, lb/hr	40							
Total Solids, lb/hr	2,480				Water			
Water, lb/hr	620	13,433	(1,780)	48,277	1,777			
Total, lb/hr	3,100	13,433	(1,780)	48,277				
Solids Weight %	80	0.003	0.003	0.003				
Total Flow, gal/min		27	-4	97	3.6			
Total Volume, ft3/min	0.39							
Average Specific Gravity	2.10							
Solids Specific Gravity (c)	2.9							
(Solids/Stream 1 Solids) %	12	0	0	0				

(a) Streams 11 and 12 are not included in the mass balance; (b) Solids in streams 5, 8, 14, 15, 18, 19, and 20 are not included in the mass balance; (c) Solids specific gravity values are from DOE-RL, 1993. They are treated as values for compacted solids without air spaces in average specific gravity and volume calculations.

Table 1-2. Attrition Scrubbing Circuit Mass Balance.

Stream Number	Citric Acid 21 (a)	Electrolyte Solution 22 (a)	Dilution Solution Slurry 23	Transport Solution Slurry 24	Slurry From Stage 1 25	Fines to Solution Clarifier 26	Dewatered Sand to Stage 2 27	Dilution Recycle Solution 28 (b)
33.7% +25mm, lb/hr								
7.9% -25 +9.5mm, lb/hr								
5.3% -9.5 +2mm, lb/hr								
40.7% -2 +0.25mm, lb/hr					7,326		7,326	
4.8% -0.25 +0.074mm, lb/hr			1	84	400	400		
7.4% -0.74 +0.028mm, lb/hr			2	129	617	617		
2% -0.028mm, lb/hr			0	3	17	17		
Total Solids, lb/hr			3	217	8,360	1,034	7,326	0
Solution, lb/hr			600	43,608	46,243	44,412	1,831	600
Total, lb/hr			603	43,825	54,603	45,445	9,157	600
Solids Weight %			0.5	0.5	15	2	80	0.003
Total Flow, gal/min	0.24 gal/hr	80 gal/hr	1.2	87	98	90		1.2
Total Volume, ft3/min							1.16	
Average Specific Gravity			1.00	1.00	1.11	1.02	2.10	
Solids Specific Gravity (c)			2.9	2.9	2.9	2.9	2.9	
(Solids/Stream 1 Solids) %	0	0	0	1	42	5	37	0

Stream Number	Transport Recycle Solution 29 (b)	Slurry From Stage 2 30	Rinse Recycle Solution 31 (b)	Recycle Water TK-101 32 (b)	Dewatered Sands 33	Solution from Screen 34	Solution Clarifier Flocculant 35 (a)	Solution Clarifier Polymer 36 (a)
33.7% +25mm, lb/hr								
7.9% -25 +9.5mm, lb/hr								
5.3% -9.5 +2mm, lb/hr								
40.7% -2 +0.25mm, lb/hr		7,106			7,106			
4.8% -0.25 +0.074mm, lb/hr		85				85		
7.4% -0.74 +0.028mm, lb/hr		131				131		
2% -0.028mm, lb/hr		4				4		
Total Solids, lb/hr		7,326			7,106	220		
Solution, lb/hr	40,000	42,432	1,777	1,777	1,777	44,208		
Total, lb/hr	40,000	49,758	1,777	1,777	8,883	44,428		
Solids Weight %	0.003	15	0.003	0.003	80	0.5		
Total Flow, gal/min	80	90	3.6	3.6		89	4 gal/hr	2.5 gal/hr
Total Volume, ft3/min					1.13			
Average Specific Gravity		1.11			2.10	1.00		
Solids Specific Gravity (c)		2.9			2.9	2.9		
(Solids/Stream 1 Solids) %	0	37	0	0	36	1	0	0

Stream Number	Solution Clarifier Underflow 37	Solution to Tank TK-102 38 (b)	Motive Solution 39 (b)	Solution to Filter 40	Solution Filter Solids 41	Solution Filter Filtrate 42 (b)	TK-102 Solution Gain 43 (b)	Recycle Solution 44 (b)
33.7% +25mm, lb/hr								
7.9% -25 +9.5mm, lb/hr								
5.3% -9.5 +2mm, lb/hr								
40.7% -2 +0.25mm, lb/hr								
4.8% -0.25 +0.074mm, lb/hr	400			400	400			
7.4% -0.74 +0.028mm, lb/hr	617			617	617			
2% -0.028mm, lb/hr	17			17	17			
Total Solids, lb/hr	1,034			1,034	1,034			
Solution, lb/hr	5,858	44,153	5,858	11,716	258	5,600	1,777	42,377
Total, lb/hr	6,892	44,153	5,858	12,750	1,292	5,600	1,777	42,377
Solids Weight %	15	0.003	0.003	8	80	0.003	0.003	0.003
Total Flow, gal/min	12	88	12	24		11.2	3.6	85
Total Volume, ft3/min					0.2			
Average Specific Gravity	1.11			1.06	2.10			
Solids Specific Gravity (c)	2.9			2.9	2.9			
(Solids/Stream 1 Solids) %	5	0	0	5	5	0	0	0

(a) Streams 21, 22, 35, and 36 are not included in the mass balance; (b) Solids in streams 28, 29, 31, 32, 38, 39, 42, 43, and 44 are not included in the mass balance; (c) Solids specific gravity values are from DOE-RL, 1993. They are treated as values for compacted solids without air spaces in average specific gravity and volume calculations.

1.1.4 Field Test Conditions

The field tests will process soil particles less than 150 mm in diameter at the rate of 10 tons/hr. Adjustments to the time and rate of processing will be determined by the field engineer. Operation times will be during normal working hours. Westinghouse Hanford Company (WHC) estimates that 200 tons of soil will be processed during Field Tests 1 and 2 to meet test objectives. An undetermined quantity of soil will be processed in the field pre-test. After the M-15-07B milestone commitment is met, additional material from 100-DR-1 or other sites may be processed depending on funding and resources.

1.1.5 Target Performance Levels

Test performance goals (TPGs) for the test will be the accessible soil levels for ^{60}Co, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{153}Eu, ^{90}Sr, ^{235}U, ^{238}U, $^{239/240}$Pu included in Table 6.2 of WHC-CM-7-5, *Environmental Compliance Manual* (WHC 1988). Reasons for selecting these levels instead of those specified in the test plan are given in DOE-RL 1993a.

System performance will also be evaluated over a range of higher and lower levels including those specified in the Test Plan (DOE/RL 1992a).

1.1.6 Equipment Sources

Due to schedule limitations, the prototype test system will be conducted using the onsite Environmental Protection Agency (EPA) trommel and coarse screens used in 300 Area soil washing tests, and supplemented with conveyors, clarifiers, spiral attrition scrubbers, vacuum filters, dewatering screens, classifiers, and other miscellaneous equipment to be procured.

1.1.7 Toxicity Characteristic Leaching Procedure Analyses

Offsite laboratories will conduct toxicity characteristic leaching procedure (TCLP) analyses in Field Test 2 for fine soils less than 0.25 mm and for soils 2 mm to 0.25 mm. In addition, radiochemical analyses of extracts from these two sediment samples will also be performed by offsite laboratories.

1.1.8 Water Treatment Tests

In addition to field tests, water treatment tests will be conducted in the laboratory using available sediment from the Pacific Northwest Laboratory (PNL) bench-scale testing described in DOE-RL 1993a. These water treatment tests will include the following:

- A bench-scale batch processing system to assess field test recycle water systems for contaminant buildup and other process factors. Water treatment will include flocculation and filtration.
- Water treatment tests to treat spent process water from the field tests.

1.1.9 Contaminated Soil Disposal

Contaminated soils smaller than 0.25 mm will be placed in appropriate containers and handled in accordance with the Waste Control Plan. Clean soils, both processed and unprocessed, will be returned to the original excavation site after the field tests are completed. Spent process water will be treated as needed and then evaporated or discharged.

1.2 OBJECTIVES AND MEASUREMENTS

Objectives and measurements for the Soil Washing Treatability Tests are listed in Sections 1.2.1 through 1.2.6.

1.2.1 Chemical and Radioactivity Levels

Soil processed during field tests will be analyzed for chemical and radioactivity levels and compared for consistency with results from the PNL bench-scale testing.

1.2.2 Soil Returned to the Site

Field measurements of the mass and percentage of each size fraction of feed and processed soils will be used to verify that the percent reduction (by weight) achieved by field-scale processing is consistent with previous bench-scale test results.

1.2.3 Water Treatment

Water treatment requirements and recycling needs will be assessed in the laboratory using available sediment from the PNL bench-scale testing (DOE-RL 1993a). Assessment will be made of contaminant buildup and treatment efficiency in removing contaminants from the recirculating liquids that will become the process effluent. These evaluations will include EPA Level II analyses of the feed water, the recirculating liquids before treatment, and system effluent after treatment.

1.2.4 Scale-Up

The performance data of the soil washing equipment used in the field tests will be analyzed to determine the requirements for scale-up to a full-scale (e.g., 100 ton/hr) system. By a combination of field and bench-scale tests, the following will be determined:

- Operating utility requirements such as the consumption of chemicals, power, and water
- Settings of equipment controls
- Energy input requirements
- Soil/water feed ratios, chemical ratios, pressures, and flow rates.

1.2.5 Emissions and Safety

Emissions and/or environmental impacts will be assessed and as low as reasonably achievable (ALARA) practices will be followed. Air monitoring results, and exposure levels detected by Health Physics personnel, if any, will be reported.

1.2.6 Real-Time Radiation Monitoring

Sodium iodide detectors will be installed on the feed conveyor and three additional conveyors to provide real-time, quantitative radiation monitoring of processed soils (Appendix A). Data will be used as needed to make field changes required to improve system performance, and to assess the viability of using real time monitors for process control.

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2.0 PILOT PLANT TEST DESCRIPTION

The Pilot Plant Tests of soil washing equipment will consist of three parts: the field pre-test, Field Test 1, and Field Test 2. The amount of soil required for the field pre-test is not set and will depend on how quickly the system can be fine tuned to meet the requirements for Field Tests 1 and 2. It is anticipated that Field Tests 1 and 2 will process approximately 100 tons each during approximately 10 hours of actual processing per field test. Several runs are planned for each field test. Each run is scheduled to process soil for up to 4 hours per day. Equipment for all field tests will include screens, conveyors, a trommel, a spiral classifier, an attrition scrubber, rotary vacuum filters, and a dewatering unit.

Figure 1-1 is a process flow diagram of the testing arrangement to be used for the Pilot Plant Tests with baseline material balance numbers. Figure 1-2 is a general arrangement of the soil washing equipment. The Soil Washing Treatability Tests will evaluate the ability of two treatment processes, physical and chemical washing, to separate the contaminated fines fraction from raw soil, thus reducing the overall volume of contaminated material. Each of the two processes will incorporate a wet sieving circuit that will use a rotating trommel, a spiral classifier, a clarifier, and a rotary vacuum filter to separate the raw soil into five size fractions: > 150 mm; 150 to 25 mm; 25 to 2 mm; 2 to 0.25 mm; and < 0.25 mm.

Each of the two processes will also incorporate an attrition scrubbing circuit that will use a two-stage attrition scrubber, a spiral classifier, a dewatering screen, a clarifier, and a rotary vacuum filter to scrub the 2 to 0.25 mm particles leaving the spiral classifier in the wet sieving circuit and separate the material into two size fractions: 2 to 0.25 mm and < 0.25 mm.

In both processes, the wet sieving circuit will use recirculated process water for washing and slurry transport. In the physical washing process, the attrition scrubbing circuit will also use recirculated process water. However, in the chemical washing process, the attrition scrubbing circuit will use an aqueous electrolyte solution rather than recirculated process water to enhance removal and inhibit reabsorption of ^{137}Cs. The electrolyte solution will contain 0.5 *M* ammonium citrate as well as sufficient citric acid to adjust the pH to 3.

The two recirculating liquid circuits will be isolated from one another. Each liquid circuit will include a clarifier and a rotary vacuum filter to remove solids prior to recycling. Each liquid circuit will also include a recycle storage tank to provide surge storage capacity.

Process water and solution will be treated as needed and then disposed in accordance with the Waste Control Plan. Contaminated soils smaller than 0.25 mm will be stored in approved containers and disposed in accordance with the Waste Control Plan. Clean soil, both processed and unprocessed, will be returned to the site after the field tests are completed.

2.1 SOIL WASHING EQUIPMENT

The baseline features for the soil washing equipment to be used during testing are described in the following sections. The operating parameters described here may be altered during operation by the process described in Section 2.3.1. Any changes will be detailed in the final test report.

The equipment will be installed and maintained in accordance with individual installation, operating, and maintenance procedures detailed in separate documentation. For example, an operating and maintenance manual (EPA 1987) will provide the required procedures for setup, startup, operation, shutdown, demobilization, and maintenance of the trommel. This manual came with the trommel trailer when it was transferred to the U.S. Department of Energy (DOE), Richland Operations Office (RL) from the EPA Risk Reduction Engineering Laboratory. Similar information for procured equipment will be supplied by the Sellers.

2.1.1 Grizzly

In the wet sieving circuit, raw feed soil will be fed to a 150 mm grizzly. The oversize material (larger than 150 mm) will exit the system, while undersize material (smaller than 150 mm) will travel up a conveyor belt and fall onto the primary screen.

2.1.2 Primary Screen

The primary screen will separate the soil into two sizes: 150 to 25 mm and smaller than 25 mm. The 150 to 25 mm oversize soil will pass under recirculated water sprays to remove any associated fines and then exit the system by conveyor belt to a cone pile. The water and fines slurry resulting from the spray step will be collected and gravity fed to the spiral classifier for further processing. The undersize material (smaller than 25 mm) will fall to the conveyor belt in the bottom of the hopper under the screen for transport to the trommel. The primary screen features are listed below:

- Screen dimensions: 2.5 x 8 ft
- Screen opening size: 25 mm
- Slope: 5 degrees
- Soil flow rate and underflow percent solids: See Figure 1-1 and Table 1-1
- Nozzle pressure and flow rate: 40 lb/in^2 and 10 gal/min.

2.1.3 Trommel

In the trommel, the soil will pass under high pressure recirculated water sprays to separate attached fines from the larger particles and to break up clumps. This spraying will be directed at the soil as it moves through a rotating 2 mm screen. The majority of the undersize soil (smaller than 2 mm) will exit the trommel as a slurry. The washing section of the trommel follows the initial screening section. This section will further agitate the soil to fully separate the individual particles. In the final section of the trommel, the material will pass under recycled rinse water sprays. Any remaining undersize particles smaller than 2 mm will pass through a final screen to combine with the slurry from the initial screen at the front end of the trommel and be pumped to the spiral classifier. Oversize particles between 25 and 2 mm will discharge onto a belt conveyor for transport to a cone pile. The trommel features are listed below:

- Rotating drum size: 4.5 ft diameter x 21 ft
- Initial screen area: 56 ft^2
- Final screen area: 28 ft^2
- Screen opening size: 2 mm
- Slope: 3 degrees
- Rotation speed: 5 rpm
- Soil flow rate and underflow percent solids: Figure 1-1 and Table 1-1
- Initial rinse nozzle supply pressure and flow rate: 60 lb/in^2 at 200 gal/min by internal pump
- Washing nozzle supply pressure and flow rate: 40 lb/in^2 at 20 gal/min
- Final rinse nozzle supply pressure and flow rate: 40 lb/in^2 at 75 gal/min
- Retention time: 3 minutes.

2.1.4 Spiral Classifier

The oversize particles (between 2 and 0.25 mm) will discharge by gravity from the upper end of the wet (i.e., the first) sieving spiral classifier to the first stage scrubber. The undersize particles (smaller than 0.25 mm) will overflow from the pool as a slurry and be pumped to the water clarifier. In the scrubber (i.e., the second) spiral classifier, the oversize particles will discharge by gravity from the upper end of the spiral to the second stage scrubber. The undersize particles will overflow from the pool as a slurry and be pumped to the solution clarifier. The spiral classifier features are listed below:

- Slope: 16.2 degrees
- Rotation speed: 15 rpm
- Soil flow rate and underflow percent solids: See Figure 1-1 and Tables 1-1 and 1-2

- Volume: 50 gal
- Pool area: 5.1 to 8.1 ft^2.

2.1.5 Attrition Scrubbers

In the first stage scrubber of the attrition scrubbing circuit, a pair of impellers rotating in each of two tanks will produce surface erosion on the oversize particles (between 2 and 0.25 mm) from the wet sieving spiral classifier. The solids concentration in these tanks will be controlled by addition of water or solution. Water will be used in field test #1 and, in field test #2, an electrolyte solution (0.5 *M* aqueous ammonium citrate containing sufficient citric acid to adjust the pH to 3) will be used. The first stage scrubber discharge will be diluted, and the slurry will be pumped to the scrubber spiral classifier for fines removal before entering the second stage scrubber. On the basis of the PNL bench-scale tests (DOE-RL 1993), 10% of the first stage feed and 3% of the second stage feed will become fines of less than 0.25 mm. The discharge from the second stage scrubber will be diluted and pumped as a slurry to the dewatering screen. The attrition scrubber features are listed below:

- Volume, each of 4 cells: 10 ft^3
- Power input to each of 4 cells: 15 hp
- Rotation speed of each 2-bladed, 18-in diameter impeller: 288 rpm
- Soil flow rate, ammonium citrate, and citric acid addition rates: See Figure 1-1 and Table 1-2
- Retention time each cell: 16 minutes.

2.1.6 Dewatering Screen

The dewatering screen will receive the discharge from the second stage scrubber through the dewatering screen pump. Oversize particles (between 2 and 0.25 mm) will be rinsed by solution and water sprays, dewatered, and discharged onto a conveyor belt for transport to a cone pile. The volume of rinse recycle solution (stream 31) and recycle water (stream 32) is indicated for each spray as equal to the liquid content in stream 33, the oversize. This is anticipated to remove 94% of the incoming solution. For field test #2 rinse water flow may be adjusted to control the electrolyte solution removal rate from the system. Undersize particles (smaller than 0.25 mm) will pass through the screen and be pumped as a slurry to the first stage attrition scrubber. The dewatering screen features are listed below:

- Screen dimensions: 2 x 10 ft
- Screen opening size: 0.30 mm
- Slope: 5 degrees

- Soil flow rate and underflow percent solids: See Figure 1-1 and Table 1-2

- Clean water nozzle supply pressure: 40 lb/in^2

- Recycle solution nozzle supply pressure: 40 lb/in^2

2.1.7 Clarifiers

Water and solution will flow through flash mix and flocculation tanks integral with both clarifiers. Polymer and flocculent will be added to these tanks as required to assist in adequate clarification of the overflow streams. The two underflow streams containing the settled solids from the water and solution clarifiers will be pumped to the water and solution rotary vacuum filters, respectively. The clarified water and solution overflow from the clarifiers will be combined with the filtrate and be pump recirculated through separate recycle tanks. The water will be recycled through tank TK-101 and back to the primary screen and trommel. The solution will be recycled through tank TK-102 to the second stage scrubber and dewatering screen. The clarifier features are listed below:

- Projected plate area: 584 ft^2

- Plate loading rate: 0.17 gpm/ft^2

- Soil flow rate, overflow, and underflow solids concentration: See Figure 1-1 and Tables 1-1 and 1-2

- Chemical feed rate to the flash mixing and flocculation tanks: See Figure 1-1 and Tables 1-1 and 1-2

- Volume of the flash mix/flocculator tank: 423 gal

- Volume of the settling tank: 510 gal

2.1.8 Rotary Vacuum Filters

In each rotary vacuum filter, the contaminated fines (smaller than 0.25 mm) will be discharged to a belt conveyor and transferred to approved containers. The water and solution filtrate will be combined with the water and solution overflows from the clarifiers and be pump recirculated through separate recycle tanks. The water will be pump recycled through tank TK-101 and back to the primary screen and trommel. The solution will be recycled through Tank TK-102 and then to the second stage scrubber and dewatering screen. The rotary vacuum filter features are listed below:

- Water

  - Filtration area: 132 ft^2
  - Rotation speed: 0.5 - 5.0 rpm
  - Soil flow rate, and filter cake solids concentration: See Figure 1-1 and Table 1-1
  - Vacuum pressure and flow rate: 20 inHg at 740 cfm

- Filtrate pressure and flow rate: 30 psi

- Solution
  - Filtration area: 56 ft^2
  - Rotation speed: 0.25 - 1.5 rpm
  - Soil flow rate, and filter cake solids concentration: See Figure 1-1 and Table 1-2
  - Vacuum pressure and flow rate: 20 inHg at 488 cfm
  - Filtrate pressure and flow rate: 20 psi

2.2 FIELD PRE-TEST

The goal of the field pre-test is to ensure that the soil washing system and equipment are functioning properly so that the requirements and objectives for treatability Field Tests 1 and 2 can be met. Any necessary equipment modification or process reconfiguration will be made during this test. Data for scale-up equipment will be gathered, where practical. Operation during the field pre-test will also allow the operators to become familiar with the equipment. There is no set tonnage of soil required to perform the field pre-test. The actual tonnage processed will depend on the time required to get the system functioning properly and for operators to become familiar with its operation.

2.2.1 Test Site Location

The field pre-test will be conducted in an area located adjacent to the 116-D-1B Trench just outside the east fence at the northeast corner of the 100-D Area in Operable Unit 100-DR-1 (DOE-RL 1993). The projected equipment arrangement is shown in Figure 1-2.

2.2.2 Process Description

Soils for all three tests (pre-test, Field Test 1, and Field Test 2) will be excavated and stockpiled prior to actual processing. The estimated excavation dimensions are approximately 10 ft wide, 25 ft deep, and 50 ft long. The material will be dug from two backhoe positions with the backhoe excavating about half of the material from each position.

Soils will be separated into two piles: uncontaminated and contaminated. The uncontaminated soils overlaying the contaminated soils will be removed from the first backhoe setup. Once these soils are removed and stockpiled, the contaminated soils will be removed and stockpiled. The backhoe will then reposition and repeat the process. The overall excavation and excavation sequence are illustrated in Figure 2-1 and 2-2 respectively. Upon completion of the material removal process, the excavation will be enclosed with safety netting for security purposes. It will also be covered with tarp for dust control purposes.

Figure 2-1. Overall Excavation Plan for the Soil Washing Field Test.

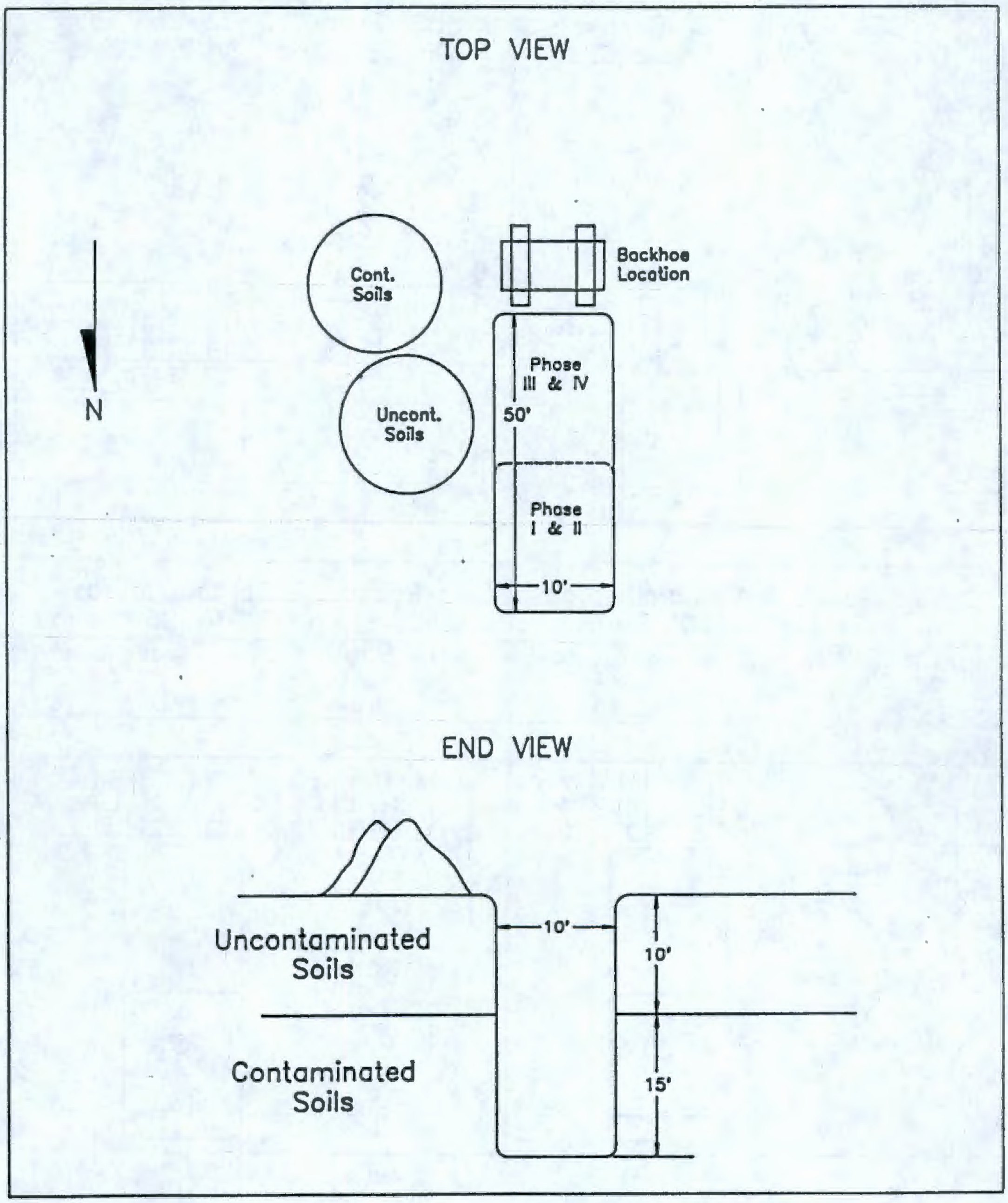
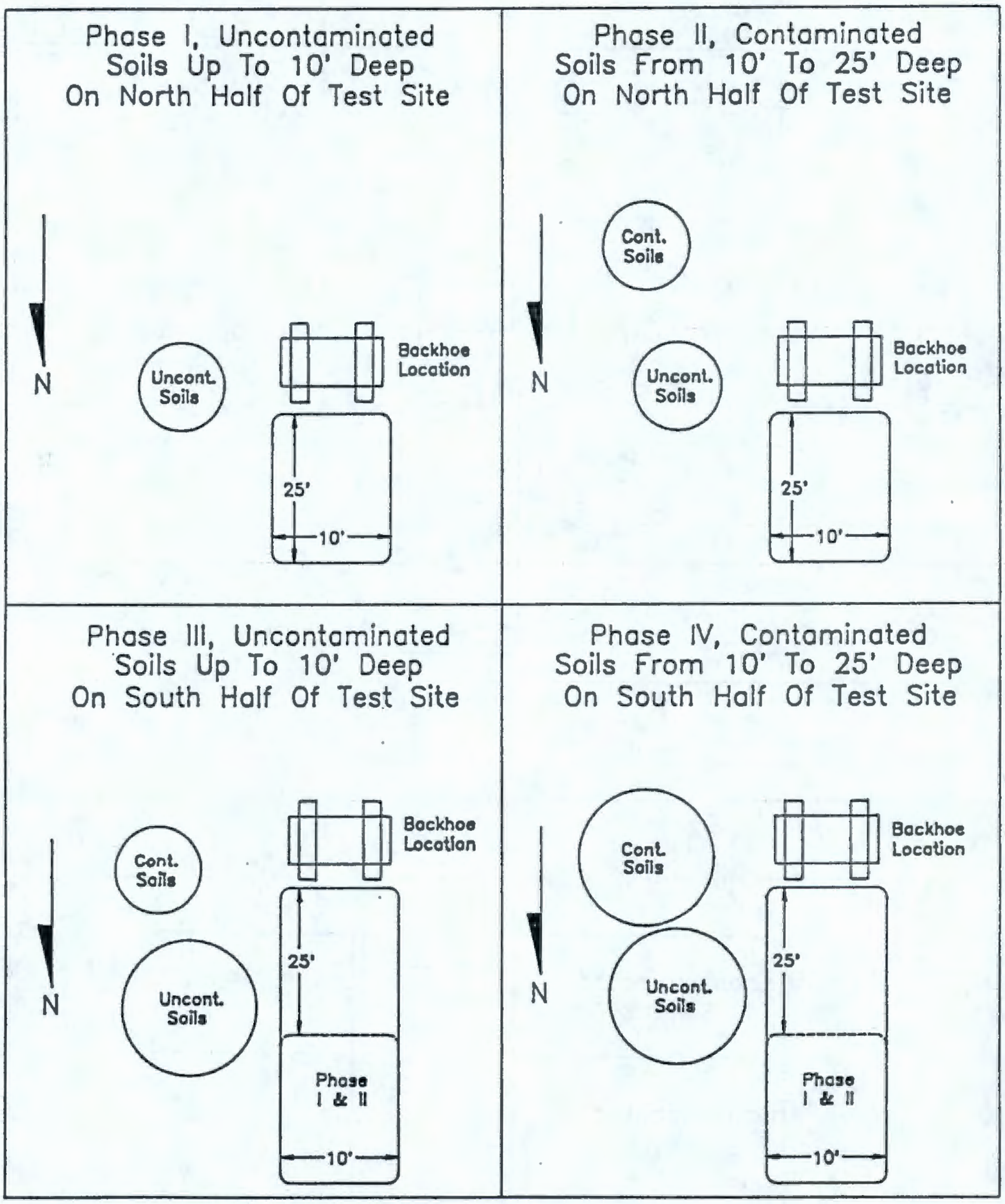


Figure 2-2. Excavation Sequence for the Soil Washing Field Test.



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This will result in approximately 300 tons of uncontaminated soils and 500 tons of contaminated soils. Uncontaminated soils will be used for most of the pre-test processing but contaminated soils may also be used if appropriate. Both piles will be covered with tarps to control dust.

As shown on Figure 1-1, with flow rates listed in Table 1-1 for the wet sieve circuit and Table 1-2 for the attrition scrubber circuit, the process will discharge soil that has been washed and classified by size into four cone piles. Soil weight flow rates will be monitored on each of the conveyors. If contaminated soils are processed, then radiation levels will also be monitored. Each cone pile may be up to 100 yd^3 (240 tons) with a diameter of 32 ft and a height of 10 ft. Fines from the vacuum filters will be stored in appropriate containment. Processing soil through the system will create eight different clean soil or liquid streams. These streams are shown in Figure 1-1 and listed below. All soil streams have associated moisture.

- > 150 mm material from the soil feed grizzly
- 150 to 25 mm material from the primary vibrating screen, stream 2
- 25 to 2 mm material from the trommel, stream 7
- 2 to 0.25 mm material from the dewatering screen, stream 33
- < 0.25 mm fines from the water rotary vacuum filter, stream 17
- Wet sieving water in tank TK-101, stream 19
- < 0.25 mm fines from the solution rotary vacuum filter, stream 41
- Attrition scrubbing water in Tank TK-102, stream 43.

Clean soils will be returned to the excavation after completion of field testing or placed in containers for future use. Efforts will be made to avoid free, drainable water from any of the cone piles.

The field pre-test will assess the performance of individual pieces of equipment and may be interrupted at times to permit adjustments, refinements, and modifications. Retention time and power input will be increased in the attrition scrubbers by reducing the soil feed rate to the grizzly. Rate of the attrition will be evaluated as affected by retention time and power input. Minor adjustments in solids concentration in the attrition scrubbers will be obtained by adjustments of spiral classifier retention time (pool area) and screw speed. Dewatered sand moisture content will be evaluated with and without fan operation in the dewatering screen to assess the affect on the presence of drainable water. Chemical feed rates to the flash mixing and flocculation tanks of both clarifiers will be adjusted. The moisture content in discharged soils will be evaluated to avoid drainable water.

Electrolyte solution chemicals will not be added in the field pre-test. They will be added in Field Test 2 after adjustments to the scrubber solution process have been made with water and soil only. At that time, ammonium citrate and citric acid feed pump adjustments will be made to maintain needed solution concentrations.

2.2.3 Sampling Strategy

The purpose of the field pre-test is to get the equipment functioning properly and to obtain operational experience. Therefore, no samples will be designated for laboratory chemical/radiochemical analyses. Random samples will be taken as deemed necessary by the operating personnel in the field. These samples will allow field measurements or observations of physical properties such as flow rates, percent solids, percent moisture, degree of separation, and consumption of power and chemicals. Results of these measurements will be recorded in the field logbook.

There will be an initial checkout of the soil radiation monitors on the feed conveyor and the three clean soil conveyors. Operator training will be performed as required for safe and efficient operation. Field supervisors will ensure that the system works properly and that all operators are qualified.

2.2.4 Fugitive Dust Control

Control of fugitive dust from the action of dumping feed material onto the grizzly will be addressed during the field pre-test. The effect of dust control water on the amount of fines that adhere to the > 150 mm material will be evaluated. As the amount of water used for dust control increases and the amount of fugitive dust decreases, it is expected that the amount of fines in the > 150 mm clean pile will also increase. With less water used, the potential for fugitive dust is higher, but the amount of fines in the > 150 mm pile may decrease (DOE-RL 1993b). The flow rate and total quantity of fugitive dust control water applied will be varied to examine its effect. The technique used to dump the feed material into the hopper will be observed and adjusted to determine what is an appropriate compromise between adequate dust control and minimum fines in the > 150 mm material.

2.2.5 Process Water

Process operators will use a tank truck to transport fresh water to the water recycle tank and to the solution recycle tank. From these tanks, the water (and solution in Field Test 2) will be pumped into their respective process circuits and eventually reach the water clarifiers, solution clarifiers, and filters. Clarified water and filtrate will be recycled to the water tank (TK-101), and clarified solution and filtrate will be recycled to the solution tank (TK-102).

The anticipated process water consumption for this test is unknown. Water use will be dependent on the processing time required to achieve the goals of the field pre-test and the success achieved in reducing the amount of water used in the system by evaporation, solids moisture, and dust sprays. Any water remaining in these tanks (TK-101 and TK-102) at the end of the pre-test will be available for use in Field Test 1.

2.2.6 Processed Material Disposal

On completion of the field pre-test, processed and unprocessed material from the excavation will be piled to one side for backfill after completion of Field Tests 1 and 2. After soil replacement in the excavation, the surface will be contoured as required to approximate its original profile.

2.3 FIELD TEST 1

Field Test 1 will be conducted using water in both the wet sieving and attrition scrubbing circuits and contaminated soils. It will be at the same location as the field pre-test described in Section 2.2. It is not expected to require any additional equipment mobilization or demobilization. Figure 1-2 shows the general arrangement of the equipment and its approximate layout adjacent to Trench 116-D-1B.

The purpose of Field Test 1 is to process contaminated soils to determine the effectiveness of wet sieving and attrition scrubbing with water as a means of reducing the volume of contaminated soils. The goal of this test is to reproduce, at pilot scale, the bench-scale test results (DOE-RL 1993) where the volume of the contaminated soils was reduced by up to 88% by weight. Soil particles smaller than 0.25 mm contain most of the contamination. Wet sieving is designed to wash and remove soil larger than 2 mm and thus reduce the total amount of contaminated soil 47% by weight. Attrition scrubbers are designed to treat soil between 2 and 0.25 mm and thus reduce the total amount of contaminated soil an additional 41% by weight. Field Test 1 will process a total of approximately 100 tons of soil at a rate of approximately 10 tons/hr.

The amount (% by wt) of soils that can be released will be assessed for 200%, 100%, 50% and 10% of the TPGs for gamma emitting radionuclides and Cr (Table 2-1). This assessment will be based on sieved soil fractions to show potential results if the separation sizes used in the system were modified.

The operating variable expected to have the most affect on soil radionuclide concentrations is retention time in the attrition scrubbers. To obtain extra retention time, with a resulting lower radionuclide concentration in the oversize off the dewatering screen and a higher ratio of power input to soil weight, the soil feed rate to the grizzly will be reduced. Solids concentration in the attrition scrubbers will be adjusted as described in Section 2.2.2 to obtain maximum soil quantities with the radionuclide concentrations below TPG.

2.3.1 Process Description

Feed material for Field Test 1 will be retrieved from the contaminated soil stockpile described in Section 2.2.2. The material will be fed from the stockpile to the main grizzly by a front end loader in the manner determined during the field pre-test. Water for dust control will be applied as determined by the field pre-test. If this results in too much fugitive dust or too many fines in the > 150 mm material, adjustments will be implemented in the field based on the judgement of the facility engineer, the safety engineer, and the health physics technician (HPT) assigned to the project.

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Table 2-1. Sample Analysis for 100 Area Soil Washing Pilot Plant Tests.[a]

Category of Analysis	Analyte of Interest	Analytical Method[b]	Soil: MDC[c] pCi/g Onsite	Soil: MDC[c] pCi/g Offsite	Soil: TPG[d] pCi/g	Soil: 116-D-1B Average[d] pCi/g	Water and Solution: MDC[c] pCi/L Onsite	Water and Solution: MDC[c] pCi/L Offsite	Water and Solution: TPG pCi/L[d]
Radionuclides: EPA Analytical Level V	Cesium-137	Gamma Spectrometry	0.1	0.1	30	205	100	0.1	2,000
	Cobalt-60	Gamma Spectrometry	0.1	0.1	7.1	15	100	0.1	1,000
	Europium-152	Gamma Spectrometry	0.2	0.2	15	177	200	0.2	
	Europium-154	Gamma Spectrometry	0.2	0.2	14	17	150	0.2	
	Plutonium-239,240	Alpha Spectrometry	3	0.6	190	2.74	10	0.6	
	Strontium-90	Low Background Beta	3	1	2,800	12.5	50	2	80
			CDRL	(mg/kg)	mg/kg	mg/kg	CRDL (µg/L)		ppb
Metals: EPA Analytical Level II[e] Level III[e]	Aluminum	[e]	5,900	20		56,700	200	200	
	Antimony	[e]	19	6		<19	60	60	16,000
	Beryllium	[e]	NA	0.5		NA	5	5	53
	Cadmium	[e]	14	0.5		<14	5	5	11
	Chromium	[e]	5	1	1,600	58	10	10	110
	Copper	[e]	5	2.5		61	25	25	120
	Iron	[e]	20	10		68,300	100	100	3,000
	Manganese	[e]	25	1.5		1,154	15	15	500
	Nickel	[e]	6	4		24	40	40	1,600
	Silver	[e]	12	1		<12	10	10	10
	Zinc	[e]	3	2		138	20	20	1,100

a This table is compiled from Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities (WHC 1992) and the Statements of Work for the laboratories.

b All analytical methods shall be Westinghouse Hanford Company approved methods.

c MDC refers to the Minimum Detectable Concentration for radionuclides and CRDL refers to Contract Required Detection Limit for all other constituents. For all analyses, precision is expressed as 20 Relative Percent Difference (RPD); accuracy is expressed as 75 to 125 percent recovery (%R).

d Test Performance Goals (TPG) based on Target Performance Levels (TPL) and Purgewater Standards from the Environmental Compliance Manual (6.0, Soils and 8.0, Purgewater)(WHC 1988). Trench 116-D-1B Averages are taken from Tables 4.6, 4.7 and 4.8 of 100 Area Soil Washing Bench-Scale Tests (DOE-RL 1993) and (DOE-RL 1993).

e Onsite Level II analysis for 90% of samples by Pacific Northwest Laboratories (PNL) using XRF for soils and ICP/MS for liquids. Offsite Level III analysis for 10% of samples by offsite laboratory using Method SW-846-6010 (Inductively Coupled Plasma as specified in Test Methods for Evaluating Solid Waste (EPA 1990).

As soil is processed through the system, there will be six different soil streams created. These streams are shown in Figure 1-1 and listed below.

Potentially Clean Streams

- > 150 mm material from the soil feed grizzly
- 150 to 25 mm material from the primary screen, stream 2
- 25 to 2 mm material from the trommel, stream 7
- 2 to 0.25 mm material from the dewatering screen, stream 33

Contaminated Streams

- < 0.25 mm fines from the water rotary vacuum filter, stream 17
- < 0.25 mm fines from the solution rotary vacuum filter, stream 41

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In Field Test 1, the system will process material for a maximum of 4 hr/day, which will amount to about 40 tons of feed material per day. The system will be closely monitored and adjustments will be made as required to balance flows and keep operation running smoothly. Belt scales will be used to measure and record the weight of material transported on the system conveyor belts. Also, real-time radiation monitors will be used to monitor material on four of the conveyor belts (i.e., the soil feed, 150 to 25 mm, 25 to 2 mm, and 2 to 0.25 mm). These data will be used to guide adjustments to process parameters, if necessary. Since the filter solids (streams 17 and 41) are expected to be contaminated above the proposed TPGs, they will not require routine monitoring at their points of discharge from the filter solids discharge conveyors. Rather, they will be monitored after they are transferred to approved containment.

2.3.2 Sampling Strategy

To determine the performance of Field Test 1, samples will be taken before, during, and after the processing period, in accordance with the sampling and analysis schedule described in Section 3.0. The data from this sampling and analysis will be evaluated and presented in the final report for the Soil Washing Treatability Test.

2.3.3 Process Water

The process water will be supplied in the same manner as described above for the field pre-test. Clean water will be hauled to the site, where it will be pumped into two tanks that will feed the system through the recycle pumps, shown as streams 20 and 44 on Figure 1-1. After the water flows through the system, it will recycle to these same two tanks for reuse. If water in tanks TK-101 and TK-102 becomes contaminated to the point of contaminating clean soil, this will be replaced with fresh water. Residual contaminated water will be treated (see Section 4.0) prior to final disposal.

2.3.4 Containment Measures

At the point of exit for each stream, consideration has been given to the need for some type of containment to minimize water losses. For the potentially clean streams, no containment will be required. Equipment will be adjusted during the field pre-test in an effort to avoid free, drainable water from any of the cone piles.

The fines smaller than 0.25 mm from the rotary vacuum filters (streams 17 and 41) are the only streams expected to be contaminated. These fines will be collected and managed in accordance with the Waste Control Plan.

After the completion of Field Test 1, the cone piles will be removed by the front end loader. This will provide space for the piles that will be created during Field Test 2.

Although not shown in Figures 1-1 or 1-2, a third tank equal in size to the two recycle tanks will serve as secondary containment during Field Tests 1 and 2. After Field Tests 1 and 2 are completed, any water in the secondary containment tank will be managed in accordance with the Waste Control Plan. Minor losses that might occur will be monitored to ensure that no danger to worker safety, public health, or to the environment arises.

2.4 FIELD TEST 2

Field Test 2 will take place in the same location as Field Test 1 and should not require any additional equipment mobilization. Lessons learned and techniques developed during Field Test 1 will be utilized during Field Test 2. The equipment configuration and site layout will be the same as for Field Test 1 (Figure 1-2).

The purpose of Field Test 2 is to process contaminated soils to determine the effectiveness of adding an electrolyte solution to water in the attrition scrubbing circuit as a means of further reducing the volume of contaminated soils. The planned electrolyte solution is 0.5 *M* aqueous ammonium citrate containing sufficient citric acid to maintain solution pH at 3.

The goal of Field Test 2 is to reproduce the results of bench-scale tests where the volume of contaminated soil was reduced 88% by weight (DOE-RL 1993). Soil particles smaller than 0.25 mm contain most of the contamination. Wet sieving is designed to remove soil larger than 2 mm and thus reduce the contaminated soil 47% by weight. Attrition scrubbers are designed to remove soil between 2 and 0.25 mm and thus reduce the total amount of contaminated soil an additional 41% by weight. Field Test 2 will process approximately 100 tons of soil at a rate of approximately 10 tons/hr.

The amount (% by wt) of soils that can be released will be assessed for 200, 100%, 50% and 10% of the TPGs for gamma emitting radionuclides and CR (Table 2-1). This assessment will be based on sieved soil fractions to show potential results if the separation sizes used in the system were modified. The operating variable expected to have the most affect on soil radionuclide concentrations is retention time in the attrition scrubbers. To obtain extra retention time, with a resulting lower radionuclide concentration in the oversize off the dewatering screen and a higher ratio of power input to soil weight, the solid feed rate to the grizzly will be reduced. Solids concentration in the attrition scrubbers will be adjusted as described in Section 2.2.2 to obtain maximum soil quantities with radionuclide concentrations below TPG.

2.4.1 Process Description

Field Test 2 will be conducted with the same procedures and equipment as Field Test 1. The difference between Field Tests 1 and 2 is the addition of an electrolyte solution in the attrition scrubbing circuit during Field Test 2. Adjustments made during or as a result of Field Test 1 may be implemented during Field Test 2, as determined by the Field Team Leader (FTL) and the Facility Engineer.

Feed material for Field Test 2 will be retrieved from the contaminated soil stockpile described in Section 2.2.2. Handling and dumping of feed soil with the front end loader will be performed in the same manner as described for Field Test 1 or with modifications as determined appropriate by the FTL. The test will be monitored closely and adjustments made as required to balance flows and keep operations running smoothly. The system will process soil for a maximum of 4 hrs/day, or about 40 tons/day.

During processing it may be necessary to spread some of the piles to reduce their height and make room for more material. This will be accomplished with the backhoe or a front-end loader. Consideration will be given to this during system setup to eliminate as much of this work as possible.

2.4.2 Sampling Strategy

To determine the performance of Field Test 2, samples will be taken before, during, and after the processing period, in accordance with the sampling and analysis schedule described in Section 3.0. The data from this sampling and analysis will be evaluated and presented in the final report for the Soil Washing Treatability Test.

2.4.3 Process Water

The process water will be supplied in the same manner as it was for the field pre-test and Field Test 1. Clean water will be hauled to the site, where it will be pumped into the two tanks that will feed the system through the recycle pumps, shown as streams 20 and 44 in Figure 1-1. After the water flows through the two circuits it will recycle to the two tanks for reuse.

Electrolyte solution chemicals will be added to the first and second stage scrubbers. Ammonium citrate and citric acid feed pump rates will be adjusted as required to maintain the required solution concentration and pH.

Residual contaminated water and solution will be treated (see Section 4.0) prior to final disposal.

2.4.4 Containment Measures

The containment measures for Field Test 2 will be the same as those described in Section 2.3.4 for Field Test 1.

3.0 SAMPLING AND ANALYSIS

The following sampling and analysis plan applies to Field Tests 1 and 2. It details sample sizes, locations, schedules, quality assurance/quality control (QA/QC) procedures, and analytical methods for water, solution, and soil samples to be taken before, during, and after processing at locations indicated on Figure 1-1. Planned analyses are summarized in Table 2-1 and described in Section 3.5. All analysis will be performed in accordance with Table 2-1 and the Quality Assurance Project Plan contained in *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-DR-1 Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1989). Analytical levels will be in accordance with EPA guidance for data quality objectives (EPA 1987).

When samples are sieved, the following sieve sizes will be used: 25, 2, 1, 0.425, 0.25, 0.150, and 0.074 mm. When water is filtered, a 0.45 μm filter will be used.

3.1 PREPROCESSING SAMPLES

Prior to processing at the beginning of field test 1, and field test 2, a clean process water and solution sample from stream 20 (Table 1-1) and stream 44 (Table 1-2) will be taken at locations indicated on Figure 1-1 to characterize the water and solution. These samples will be no less than 3 L and will receive chemical (inductively coupled plasma/mass spectrometry [ICP/MS]) and radiochemical (gamma-spectrometry) analysis. They will also be tested for temperature and pH using Level I analytical methods (EPA 1987).

3.2 PROCESSING SAMPLES

The feed soil stream and the combined water and solution from the clarifiers and the filters (streams 14 and 38, Tables 1-1 and 1-2) will be sampled at locations indicated on Figure 1-1. In addition, samples will be taken from the clarifier inlets (streams 10 and 26), recycle water (stream 20), and recycle solution (stream 44). Also, samples will be taken from streams 9, 25, and 30 to determine the effectiveness of wet sieving and of each stage of attrition scrubbing.

For each test, the first sampling event at time 0 hours will occur when the processed material first begins appearing at the sampling points described below. Successive sampling events will occur at 1 hour intervals, with the final event occurring, just prior to completion of the test.

The following types of samples will be taken during processing:

- Two samples of the feed material will be taken from the bucket of the front end loader before it is emptied onto the grizzly. These samples will be approximately 3.5 L and will receive both chemical (XRF) and radiochemical (gamma-spec) analyses in accordance with Table 2-1. One or more of these samples will be sent to an offsite laboratory for confirmatory analyses using Level III and Level V analytical methods.

- The samples of feed material collected at the specified intervals will then be composited and submitted to the laboratory. A portion of the composite will be weighed, dried, and weighed again to allow calculation of average percent moisture. The composite will then be wet sieved. The individual fractions will be weighed and subjected to both chemical (XRF) and radiochemical (gamma-spec) analysis.

- Two samples will be taken of streams 14 and 38 just before they enter the water and solution tanks, and streams 20 and 44 just after they leave the tanks. For the first sampling event during each field test, this sample will be delayed until the feed material is observed to reach this point in the process. The subsequent samples will be taken at the defined one-hour intervals. These samples will be no less than 3.5 L. The water and solution will be analyzed for both chemical and radiochemical constituents in accordance with Table 2-1. One or more of these samples will be sent to an offsite laboratory for confirmatory analyses using Level III and Level V analytical methods.

- Two samples will be taken of slurry streams 9, 10, 25, 26, and 30. These samples will be no less than 3.5 L. These samples will be filtered and the solids will receive both chemical (ICP/MS) and radiochemical (gamma-spec) analyses in accordance with Table 2-1. One or more of these samples will be sent to an offsite laboratory for confirmatory analyses using Level III and Level V analytical methods.

- The samples collected at the specified intervals for each individual stream (9, 10, 25, 26, and 30), liquid and solids, shall be composited and submitted to the laboratory. A portion of each composite will be weighed, and the solids will be filtered out and weighed. This will allow moisture content (or percent solids) to be determined. The solids will be wet sieved, and each fraction will be weighed. The individual fractions will then be weighed and receive both chemical (XRF) and radiochemical (gamma-spec) analyses.

- During Field Test 2, samples of materials discharging from the dewatering screen and the solution rotary vacuum filter (streams 33 and 41) will be taken. These samples will be no less than 2 L. The samples will be sent to the laboratory for TCLP analysis.

3.3 POST-PROCESSING SAMPLES

Additional samples will be taken at locations indicated on Figure 1-1 at the completion of processing for each field test. The cone piles and the fines from the two rotary vacuum filters will be randomly sampled to ensure that they are representative. In some cases, a portable drum counter may be used (Appendix C). The details for this sampling are described in the following sections.

3.3.1 > 150 mm Material

This cone pile will contain the clean oversize soil off the grizzly. For purposes of the material balance, it is estimated this material will comprise 1% of the total feed, or about 1 dry ton per test (0.1 dry ton/hr). This amount is not included in the mass balance flow rates of Table 1-1. Appropriate measurements will be made to adequately determine the volume of material in the pile.

A front end loader will spread the > 150 mm pile out as evenly as possible without mixing in any other material. The pile will be made up of larger cobbles and is expected to be fairly rough.

The pile will be surveyed with a hand-held instrument to measure total beta/gamma activity. If any activity exceeding the TPGs is found, the area of that activity will be examined further. This examination will attempt to determine if the activity is the result of fines that need to be washed off during full-scale operation or if more substantial treatment may be required. Material from areas not meeting the TPGs will be placed in a portable drum counter designed to measure radioactivity by species.

3.3.2 150 to 25 mm Material

The material in this cone pile will be the oversize soil from the primary screen, stream 2. It will have been washed with sprays before it comes off the primary screen. It is estimated that this pile will make up approximately 33% of the total material or about 33 dry tons for each test (3.3 dry tons/hr). Appropriate measurements will be made to adequately determine the volume of material in the pile. In addition, this material will have been weighed by the belt conveyor scale during processing.

Using the same procedure as described in Section 3.3.1, this material will be spread out and surveyed for total activity. Any areas not meeting the TPGs will be examined for the source and will be more accurately surveyed in the portable drum counter.

One 5-gal sample of material will be composited from various locations in this pile and then weighed and wet sieved. Each fraction will then be weighed and receive chemical (XRF) and radiochemical (gamma-ray) analysis.

3.3.3 25 to 2 mm Material

This material is the oversize soil stream from the trommel, stream 7, and is expected to make up about 13% of the total or about 13 dry tons per test (1.3 dry tons/hr). Appropriate measurements will be made to adequately determine the volume of material in the pile. The material will have been weighed by the belt conveyor scale during processing.

Using the same procedure as described in Section 3.3.1, this material will be spread out and surveyed for total activity. Any areas not meeting the TPGs may be examined for the source using the portable drum counter.

After the total activity survey is complete, the pile will be randomly sampled. A total of 12 sample locations will be selected. At each location, a sample of at least 300 mL will be taken for chemical (XRF) and radiochemical (gamma-spec) analysis. A composite sample shall be collected from the 12 random locations to be analyzed for percent moisture. This composite will also be wet sieved, and the individual fractions will be weighed. The individual fractions will then be weighed and receive both chemical (XRF) and radiochemical (gamma-spec) analysis.

3.3.4 2 to 0.25 mm Clean Material

This cone pile will contain the oversize soil material discharged from the dewatering screen, stream 33. It is expected to comprise about 41% of the total, which is 41 dry tons for each test (4.1 dry tons/hr). Appropriate measurements will be made to adequately determine the volume of material in the pile. The material will have been weighed by the belt conveyor scale during processing.

Using the same procedure as described in Section 3.3.1, this material will be spread out and surveyed for total activity. Any areas not meeting the TPGs may be examined for the source using the portable drum counter.

After the total activity survey is complete, the pile will be randomly sampled. A total of 12 sample locations will be selected. At each location, a sample of at least 300 mL will be taken for chemical (XRF) and radiochemical (gamma-spec) analysis. A composite sample shall be collected from the 12 random locations to be analyzed for percent moisture. This composite will also be wet sieved, and the individual fractions will be weighed. The individual fractions will then be weighed and receive both chemical (XRF) and radiochemical (gamma-spec) analysis.

3.3.5 < 0.25 mm Contaminated Material

This material will be the fines discharged from the rotary vacuum filters, streams 17 and 41. It is expected to comprise about 12% of the total, which is 12 dry tons for each test (1.2 dry tons/hr). Appropriate measurements will be made to adequately determine the volume of material. The two streams will have been weighed by the belt conveyor scales during processing.

Using the same procedure as described in Section 3.3.1, this material will be spread out and surveyed for total activity. Any areas not meeting the TPGs may be examined for the source using the portable drum counter.

After the total activity survey is complete, the pile will be randomly sampled. A total of 12 sample locations will be selected. At each location, a sample of at least 300 mL will be taken for chemical (XRF) and radiochemical (gamma-spec) analysis. These samples will then be composited and the composite will be analyzed for percent moisture. This composite will also be wet sieved, and the individual fractions will be weighed. The individual fractions will then be weighed and receive both chemical (XRF) and radiochemical (gamma-spec) analysis.

3.3.6 Process Water

The chemical and radiochemical analyses for the process water and solution will be determined from the liquid portion of the samples taken during processing (Section 3.2).

3.4 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

All analytical samples will be subject to in-process quality control (QC) procedures appropriate for the field and the laboratory. These procedures are provided in the Quality Assurance Project Plan contained in the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-DR-1 Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1989). They will be supplemented, as necessary, by procedures incorporated in the *Environmental Investigations and Site Characterization Manual* (WHC 1988). For example, these documents will be used to define procedures for maintaining the project's field logbook and sample chain of custody records.

3.5 SAMPLE ANALYSIS

The laboratory analytical work will be done in accordance with Table 2-1 and *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1992). This quality assurance project plan (QAPjP) is designed to accommodate both water and soil samples. Soils that were not sieved and are receiving chemical and radiochemical analyses will be analyzed for metals (including chromium) using EPA methods (EPA 1990), total plutonium using alpha spectrometry, and other radionuclides using gamma spectrometry. Water samples will be analyzed for these same constituents using EPA methods for liquids. The field measurements for pH and temperature will be taken from a separate bottle.

Soils that are sieved and analyzed will be analyzed for metals using XRF and radionuclides using gamma spectrometry.

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4.0 WATER TREATMENT AND RESIDUALS MANAGEMENT

The wet sieve and attrition scrubbing processes will include independent equipment to provide suspended solids clarification and filtration before recirculation of the water and solution within the separate circuits. Flocculant and polymer will be pumped at metered rates into the flash mixing and flocculating tanks preceding the settling tank of each clarifier as needed to produce acceptable clarifier performance. Initially, the rates will be in accordance with the recommendations determined by the PNL bench-scale testing 100 Area Soil Washing: Bench Scale Test on 116-F-4 Pluto Crib Soil WHC-SD-EN-TI-268, Draft A, April 1994 (WHC 1994a). These rates are interpreted as listed in Tables 1-1 and 1-2 (streams 11, 12, 35, and 36). AQUAFLOC® 460 and 2404 along with DEARTEK® 2401[1] will be used as the flocculants in the solution clarifier. AQUAFLOC® 460 and 456C will be used as the flocculants in the water clarifier. Process water or solution will be treated as needed and then handled in accordance with the Waste Control Plan. If required, the solution and/or the water will be treated after soil processing has been completed.

Based on the PNL bench-scale analyses of water samples (DOE-RL 1993), the activities of radionuclides were near or below the minimum detectable activities (MDAs) in both two-stage attrition scrubbing waste solutions, whether or not they were treated with flocculant and polymer. These data showed no indication that the Trench 100-D-1B contaminants are soluble in water.

If it is determined that clarification and filtration are not adequate, then process effluent will be treated offline using ion-exchange. If ion exchange is used, samples will be taken two times during each ion-exchange processing day: at the beginning of the day and at the end of the day. At each sample time, a sample will be taken from the influent stream and the effluent stream after the system has stabilized. The samples will be analyzed for the constituents in Table 2-1. After confirmatory analysis, treated water or solution will be disposed in accordance with the Waste Control Plan.

As mentioned in Section 1.1.8, bench-scale laboratory tests will be conducted on a recycle system including flocculation, clarification, and filtration. One test will use available sediment from previous bench-scale testing (DOE-RL 1993). Another test will use water and solution from the field tests described in this document. This test may include ion exchange if purgewater standards need to be met.

Solids removed from the water and solution in the field tests will be disposed in accordance with the Waste Control Plan. Laboratory test waste will be managed by the laboratories in accordance with laboratory procedures.

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[1]AQUAFLOC® 460, 456c, and 2404; and DEARTEK® 2401 are registered trademarks of Grace Dearborn, Lake Zurich, Illinois.

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5.0 DATA EVALUATION

All samples receiving EPA Level III chemical analysis and EPA Level V radiochemical analysis will be validated using WHC Level B RCRA data validation procedures (WHC 1990).

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6.0 PROCEDURES

Activities for this project will be controlled and performed in accordance with the *100 Area Soil Washing Treatbility Test Plan* (DOE/RL 1992a), an approved Hazardous Waste Operations Plan (HWOP), the *Soil Physical Separations Treatability Safety Assessment for 100 and 300 Areas*, (WHC 1994) and WHC-SD-EN-SAP-005, Rev. 2, *Environmental Investigations and Site Characterization Manual*, (WHC 1988b). The applicable procedure subjects are listed below.

SUBJECT	**EII 7.7 PROCEDURE(S)**
Sampling Procedures	5.2, 5.8
Sample Handling	5.2, 5.11
Field Documentation and Logbooks	1.5, 5.1, 5.10
Equipment Decontamination	5.4, 5.5
Waste Handling and Disposal	4.2
Site Entry Requirements	1.1
Deviation From Procedures	1.4
Personnel Requirements	1.1, 1.7, 3.2
Health and Safety Requirements	1.1, 1.7, 2.1, 2.2, 2.3, 3.2
Data Management	14.1

In addition, an equipment walk down by industrial safety and a readiness review will be completed prior to start up.

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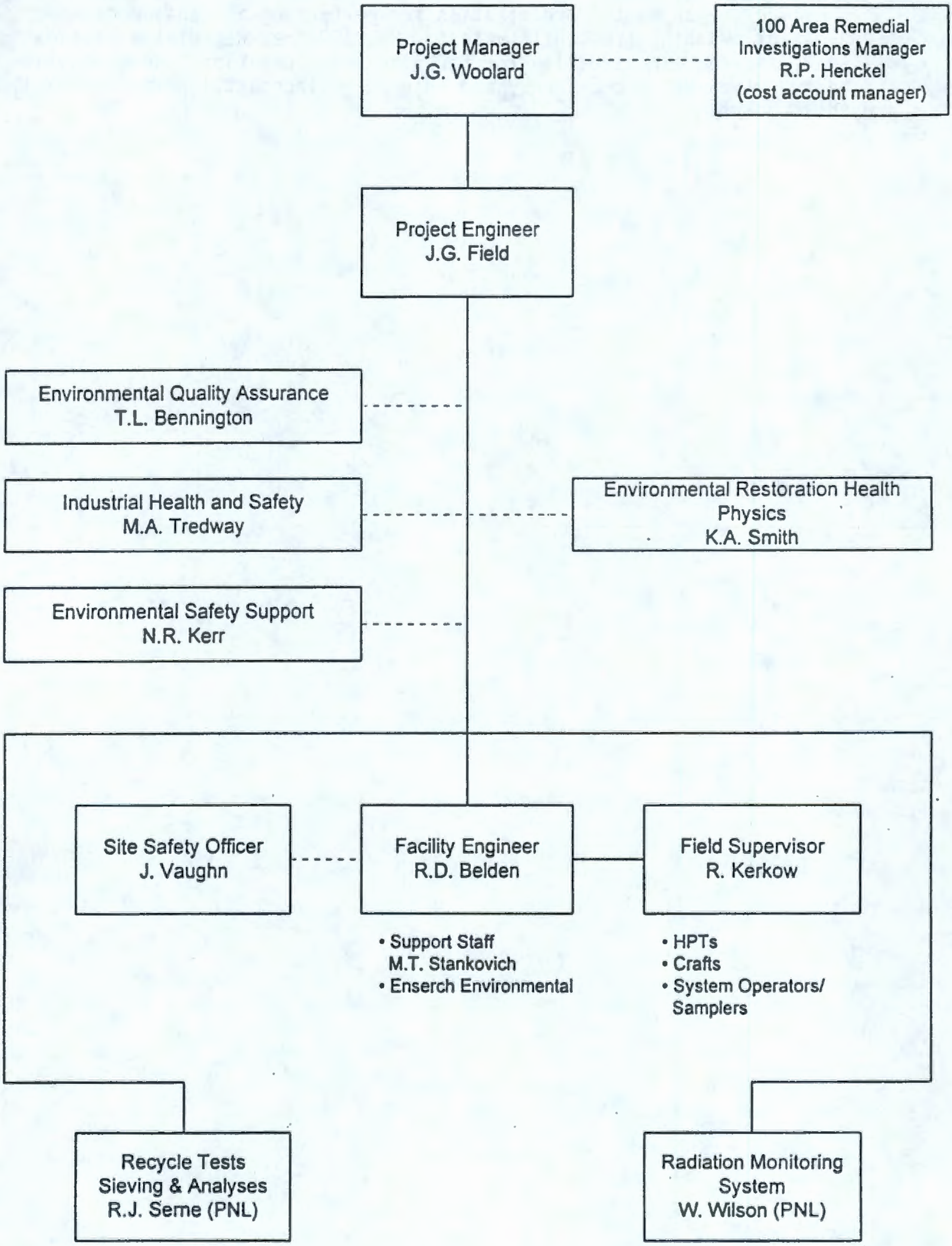
7.0 PROGRAM ORGANIZATION

Figure 7-1 shows the organization for performing all phases of the 100-DR-1 Soil Washing treatability test. WHC 100 Area Remedial Investigations will have direct responsibility for the planning, operation, and evaluation of the test. Other WHC groups, PNL, and Enserch Environmental Corporation will provide support.

Figure 7-1. 100 Area Soil Washing Treatability Test Organization.



8.0 SCHEDULE

Figure 8-1 shows the schedule for planning and performing the soil washing treatability tests and issuing a test report. The planned start of the test is mid-July 1994. This schedule is contingent on acquiring process equipment and obtaining regulatory approval of the Waste Control Plan.

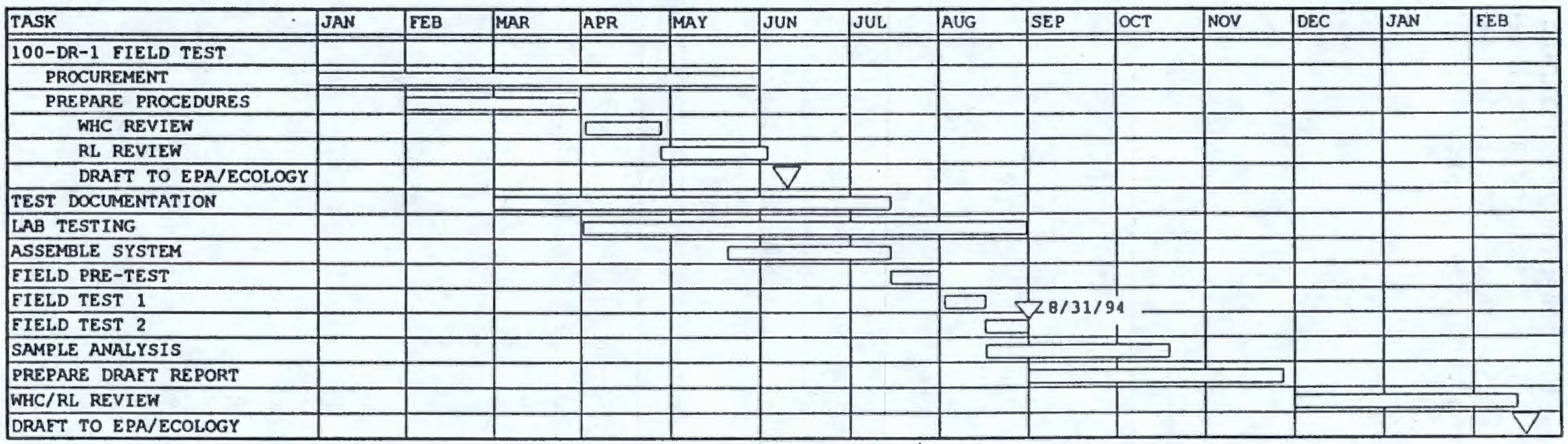


Figure 8-1. Soil Washing Treatability Test Schedule.

9.0 REFERENCES

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WHC, 1990, *Sample Management and Administration Manual*, WHC-CM-5-3, Westinghouse Hanford Company, Richland, Washington.

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WHC, 1994, *Soil Physical Separations Treatability Safety Assessment for 100 and 300 Areas*, WHC-SD-EN-SAD-005, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

100 AREA SOIL WASHING REAL-TIME RADIATION MONITORING SUPPORT

APPENDIX A
100 AREA SOIL WASHING REAL-TIME RADIATION MONITORING SUPPORT

1.0 SCOPE

Real-time radiation monitoring support will be provided by PNL during the 100-DR-1 soil washing treatability test. The field test is to be completed by August 31, 1994 in fulfillment of TPA Milestone M-15-07B.

The work will include calibration, software development, and support during installation and field operations for four sets of monitors. One set of monitors will be installed over the feed conveyor, and three sets will be installed over the processed soils conveyors. The monitors will be installed by WHC (with PNL support) over 2 ft wide conveyors. Nominal conveyor speed will be 100 feet per minute. The targeted sensitivity for radionuclides will be < 10 pCi/g for ^{137}Cs, ^{60}Co, and ^{154}Eu, and < 100 pCi/g for ^{90}Sr.

In addition to the real-time monitors, PNL will provide drum counting services (portable equipment and support) for measurement of radioactivity levels in feed soils and/or processed-rock and soil samples.

This is a test and no higher level of Quality Assurance will be required than that of PNL's Good Practices Standard (QA Level III).

At the conclusion of the testing, radiation monitoring equipment will either be returned to PNL or the equipment will be purchased by WHC at a fair market value.

2.0 DELIVERABLES

2.1 DEVELOPING AND INSTALLING MONITORS

Each of the four sets of monitors will utilize 5-in. diameter sodium iodide (TI) scintillation crystals (each array composed of 14 detectors) to measure the characteristic gamma-rays emitted by ^{137}Cs, ^{60}Co, and ^{154}Eu and the bremsstrahlung radiation emitted by ^{90}Sr (^{90}Y). A single array on each conveyor should provide the required sensitivity at the anticipated conveyor speed. Each of the 56 detectors will be tested for operability, the output gain set on each photomultiplier tube, and inoperable detectors replaced.

Electronic hardware components will be assembled and tested to acquire data from each of the 56 detectors. This may include purchasing additional equipment (up to $15,000) to replace missing equipment components. Data will include at a minimum a continuous line chart showing radiation levels on each of the conveyors, and a light or alarm indicator if the thresholds for radiation levels are exceeded. Depending on the outcome of the system calibration effort, data may include a continuous report of the absolute concentration of each of the isotopes under surveillance.

Software will be written and assembled for data acquisition and reduction in order to provide real-time quantitative results.

The systems will be calibrated in the laboratory in static and/or dynamic modes to assure reliable quantitative data in the field. Appropriate quantitative radioisotope sources, traceable to NIST will be used for this effort. Calibration checks shall also be performed in the field.

PNL will assemble detectors and electronics in the field in proper configurations, and provide support and direction to WHC to mount systems on the conveyors, and arrange for the necessary infrastructure for field operations.

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APPENDIX B

SUPPORTING LABORATORY TEST PROCEDURES

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APPENDIX B
SUPPORTING LABORATORY TEST PROCEDURES

1.0 INTRODUCTION

PNL has developed and will perform four bench-scale laboratory tests to support the 100 Area Soil Washing Treatability Test. The following sections describe these tests.

2.0 RECYCLABILITY OF WET-SIEVING PROCESS WATER

The objective of this test will be to examine the recyclability of process water resulting from wet sieving of soils smaller than 2 mm from Trench 116-D-1B. The number of times process water can be recycled will depend on two major factors. First, after several wash cycles, the increase in total dissolved solids (TDS) concentration in the wash water may require excessive quantities of flocculent, thus making further recycling less cost effective. Second, the potential buildup of TDS and radionuclides in the washwater may result in increasing residual radionuclide activities in the washed particles (0.25 mm to 2 mm) that will be treated further in the attrition scrubbing circuit. The proposed test scheme is designed to evaluate these factors and to delineate the limits of recyclability of washwater.

Each wet-sieving cycle will be conducted with 667 g of < 2 mm soil from Trench 116-D-1B. Sieving will be conducted using a 0.25 mm sieve and 3,300 ml of water. The fraction retained on the sieve (0.25 mm to 2 mm) will be air dried, counted for radionuclide (^{60}Co, ^{137}Cs, and ^{152}Eu) activity, and stored for use in attrition scrubbing washwater recycling tests. The washwater with < 0.25 mm fines will be clarified after addition of a flocculent (CAT-FLOC® L) and the supernatant will be decanted. The floc will be filtered, the filter cake will be analyzed for radionuclide content, and the filtrate will be composited with the decanted supernatant. An aliquot of the supernatant will be analyzed for turbidity, pH, conductivity, alkalinity, radionuclides, cations, and anions. The volume of the supernatant will be adjusted to 3,300 ml with make up water and reused in the wet-sieving operation.

Approximately 10 cycles of wet sieving will be conducted. Following the final recycling step, TCLP tests will be conducted on the last batch of 0.25 mm to 2 mm size fraction, and < 0.25 mm fractions (composited during recycling).

3.0 RECYCLABILITY OF ATTRITION-SCRUBBING WASHWATER

The objective of this test is to determine the recyclability of washwater resulting from two-stage attrition scrubbing of previously wet sieved fines (0.25 mm to 2 mm) from Trench 116-D-1B. Washwater resulting from two types of attrition scrubbing will be tested for recyclability. In the first set of experiments, the attrition scrubbing will be conducted with water and in the second set, the scrubbing will be conducted with an electrolyte consisting of a mixture of ammonium citrate and citric acid. It is expected that the recyclability of wash water resulting from these two sets of tests will differ because in one case the wash water will contain the electrolyte. The proposed test schemes are designed to evaluate those factors that affect the recyclability of washwater resulting from two different attrition scrubbing processes.

Each attrition scrubbing water recycling test will be conducted with 500 g of 0.25 mm to 2 mm air dried soil derived from the wet-sieving water recycling test (described in Section C.3). The first stage attrition scrubbing will be conducted with water at a pulp density of about 83% for a residence time of 30 min at an impeller speed of 900 rpm. Following scrubbing, the fines (< 0.25 mm fraction) will be washed out with 1,500 ml of water and collected in a 4-liter beaker. In the second stage, the washed coarse fraction (0.25 mm to 2 mm) will be scrubbed again at the same pulp density and residence time as the first stage and washed again with 1,500 ml of water to remove the fines. The washwater and the fines from the second-stage scrubbing will be composited with the washwater and fines from the first-stage scrubbing. The washed coarse fraction (0.25 mm to 2 mm) after the second-stage scrubbing will be dried and counted for radionuclide (^{60}Co, ^{137}Cs, and ^{152}Eu) activity. The composited washwater with < 0.25 mm fines will be clarified with a combination of flocculents (CAT-FLOC L® and POL-E-Z® 692), and the supernatant will be decanted. The floc will be filtered, the filter cake will be analyzed for the radionuclide content (^{60}Co, ^{137}Cs, and ^{152}Eu), and the filtrate will be composited with the decanted supernatant. An aliquot of the supernatant will be analyzed for turbidity, pH, conductivity, alkalinity, radionuclides, cations, and anions. The volume of the supernatant will be adjusted to 3000 mL with make up water and reused in the wet-sieving of attrition scrubbed soil fraction.

The same sequence of steps will be used in the second set of experiments in which attrition scrubbing will be conducted with an electrolyte rather than with water. However, in the second set of experiments, in addition to the other dissolved constituents, concentrations of both ammonium and citrate in the supernatant will be monitored and part of the supernatant will be used to reconstitute the electrolyte for the next attrition scrubbing cycle.

Approximately five cycles each of attrition scrubbing (with water and with electrolyte) will be conducted. Following the final recycling step, TCLP tests will be conducted on the last batch of attrited 0.25 mm to 2 mm fines and < 0.25 mm fines (composited during recycling).

4.0 FINAL WATER TREATMENT

The goal of this test will be to identify the most appropriate method of treating the final effluent to meet the purgewater criteria (PWC) established in Table 8.3 of the Environmental Compliance Manual (WHC 1993) for radionuclides and other contaminants. The clarified final effluent will be analyzed for radionuclide activities (^{60}Co, ^{137}Cs, and ^{152}Eu) and other inorganic constituents. If any of the regulated constituents exceed the PWC, additional treatment such as precipitation and ion exchange will be tested. Even though the PWC does not include regulatory limits for ^{152}Eu, NH_4^+, and citrate, the efficacy of treatment technologies such as ion exchange (^{152}Eu, NH_4^+, and citrate), break-point chlorination, and air stripping (NH_4^+), will be examined.

5.0 EFFECTS OF DUST SUPPRESSANTS

Soil washing is an ex situ process. Therefore, the soil to be treated has to be excavated and staged prior to washing. One of the concerns during this staging step is the production of nuisance dust generated during the handling of contaminated soil. Therefore, spraying of dust-suppressants has been proposed for significantly reducing the concentrations of airborne particulate generated from staged soils (Thompson et al. 1993; Sackschewsky 1993). Dust suppressants tested by these investigators included solutions of Flambinder (calcium lignosulfates), XDCA (sugar polysaccharides), and pregelled potato starch. Data generated by Sackschewsky (1993) showed that due to their binding action both XDCA and potato starch reduced the quantity of fines in two soils from the Hanford Site (a sandy soil and a silty soil). These data suggested that the use of dust suppressants has the potential to measurably affect the particle size distribution in both coarse and fine textured Hanford soils. Consequently, these dust suppressants if used on radionuclide-contaminated soils from the Hanford Site, may affect the wet-sievability and the radionuclide distribution in these soils fractions. Therefore, a set of tests has been designed to measure any potential changes in particle-size and radionuclide distribution in 116-D-1B Trench soil if this soil were treated with dust suppressants. The purpose of these tests is to assess the effect of applying dust suppressants for future use. Dust suppressants will not be used during the 100-DR-1 pilot test.

Two dust suppressants (calcium lignosulfate and XDCA) will be tested at two rates of application (2 and 4 liter per m^2). Soil samples (< 2 mm size fraction) will be treated with each dust suppressant and dried to promote crust formation. The treated samples and a control (untreated) sample will be wet-sieved with a set of sieves consisting of 2 mm, 0.425 mm, 0.25 mm, and 0.075 mm. The soil fractions retained on each sieve and the pan will be oven dried at 105 °C and counted for radionuclide (^{60}Co, ^{137}Cs, and ^{152}Eu) activity. The effects of the two dust suppressants will be assessed by comparing the particle size and the radionuclide distribution data from the three samples.

6.0 REFERENCES

Sackschewsky, M.R., 1993, *Fixation of Soil Surface Contamination Using Natural Polysaccharides*, WHC-EP-0688, UC-721, Westinghouse Hanford Company, Richland, Washington.

Thomspon, D.N., A.L. Freeman, and V.E. Wixom, 1993, *Evaluation of the Contamination Control Unit During Simulated Transuranic Waste Retrieval*, EGG-WTD-10973, Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho.

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APPENDIX C

PORTABLE DRUM COUNTER

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PORTABLE DRUM COUNTER

1.0 INTRODUCTION

As described in *Calibration and Operation of the PNL Barrel Assayer* (Arthur 1991), PNL operates a mobile apparatus (commonly called a portable drum counter) developed for measuring the radionuclide content of 55 gal drums as well as small containers. Drums containing waste are positioned on a turntable, rotated, and directly measured using both a collimated intrinsic-germanium (IG) gamma-ray spectrometer positioned at 11 equally-spaced intervals opposite the drum and 62 stationary $^{10}BF_3$ tubes embedded within two hemicycles of polyethylene moderator. Some of the advantages of this type of system are: (1) the counting instrumentation can be transported to drum-storage locations, (2) very large sample sizes can be accommodated, (3) individual isotopic analysis and total gamma activity are determined, (4) the relative vertical distribution of activity within a drum may be determined from the scans, (5) sensitivity and counting geometry variability are improved by analyzing the sum of the 11 segmented gamma-ray scans, and (6) transuranic (TRU) levels can be determined.

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2.0 DESIGN AND OPERATION

In the portable drum counter, a lead-collimated, shielded IG detector mounted on a movable platform vertically scans a drum from top to bottom. A magnetic position sensor accurate to 0.001 in. is employed by the software controlling program, "SGS," to locate the detector platform within 0.1 in. of the specific height. A barrel is mounted on a turntable which rotates the drum at approximately 30 rpm during the vertical scanning. The vertical gamma-ray scanning is normally performed in eleven, 3 in. segments for 55 gal drums, and the segment counts are summed to provide both total gamma-ray activity and specific activity, as well as individual isotopic activity. This information is useful in the event that some portion of the waste in the drum contains a highly unusual radionuclide composition.

The counting system contains a relatively large IG detector, typically with an efficiency for gamma-ray detection of between 19% and 30% (relative to a 3 in. x 3 in. right-circular sodium-iodide cylindrical detector). The detector is shielded on the side by 1-in. of lead. A 2-in. lead collimator is used on the face of the diode with a slit of height 0.25 in. or 1.0 in. depending on the activity of the waste, exposing the full width of the diode.

The neutron detectors that surround the drum measure neutrons emitted by TRU isotopes within the waste. The detector are embedded in polyethylene moderator to enhance the efficiency of the measurement. Additionally, TRU concentrations for Pu, Am, and Cm can be directly measured with the IG detector if their concentrations exceed about 1 nCi/g and if their gamma-ray emissions are not dominated by fission or activation product radiations.

Gamma-ray spectral data from the IG detector are collected and stored using a commercial software program. The resulting 11 spectra from the analysis of a typical drum are then summed together. The summed data are then reduced and experimentally determined efficiency curves are generated.

The contents of a drum are assumed to be packed homogeneously in the first analysis. For barrels with detectable activity, the analyst checks this assumption by observing the count rate for each segment and by looking at the resulting disintegration-per-second (dps) factors on radioisotopes with gamma-rays of several energies, such as ^{239}Pu, ^{60}Co, ^{125}Sb, ^{134}Cs, ^{152}Eu, and ^{154}Eu. If a discrepancy is noted in the dps factor, then several methods are available to correct the discrepancy. For example, the segments can be analyzed individually using an appropriate technique to approximate a more accurate attenuation correction.

3.0 REFERENCES

Arthur, R.J., 1991, *Calibration and Operation of the PNL Barrel Assayer*, PNL-7739, Battelle Pacific Northwest Laboratory, Richland, Washington.

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